



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 10, October 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Review on Experimental Investigation in Paver Blocks by Replacing Sand with Manufacturing Sand and its Overview

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ABSTRACT: The current study is primarily concerned with Paver blocks, also known as concrete or interlocking pavers, which are extensively used in landscaping and construction for paths, driveways, and patios. Experiments were carried out on M30 grade concrete. This has forced mankind to use other materials in construction projects such as M-sand and fly ash. Cement, sand, aggregates (such as crushed stone or gravel), and water are the essential constituents. In order to make a uniform mixture, the basic elements are thoroughly combined in a concrete mixer. The mixed concrete is then poured into a variety of Moulds of varying shapes and sizes. These moulds can have elaborate motifs and patterns. Vibrators are used to compact the concrete within the moulds, reducing air spaces and providing a dense result. Paver blocks are normally kept to cure for a specified period of time in a controlled environment with temperature and humidity controls. This is a critical step in the development of strength. After curing, the blocks are taken from the moulds and may be subjected to surface treatments such as shot blasting or acid washing to improve aesthetics. Paver blocks are examined for size, surface polish, and strength to verify that they satisfy industry requirements. Several tests are carried out on paver blocks to determine their quality and durability. In this study, we present the results of several cube-based experiments. At the end of 7, 14, and 28 days, the compressive strength was determined. At the end of 28 days, the water absorption test was determined. It was discovered that the compressive, flexural, and tensile strength of concrete formed using manufacturing sand were studied.

KEYWORDS: Manufacturing sand, paver blocks, fly ash, compression test, tensile test, flexural test, water absorption test

I. INTRODUCTION

Manufacturing paver blocks is a technique that produces long-lasting and aesthetically beautiful pavement materials that are commonly used in landscaping, road construction, and outdoor flooring projects. The following main steps are commonly involved in this process. The manufacturing process begins with the selection of raw ingredients such as cement, sand, aggregates (typically crushed stone or gravel), and colouring additives. The strength and beauty of the paver blocks are highly dependent on the quality of these components. In a concrete mixer, the basic components are combined in precise amounts. Water is added to the concrete mix to make it workable. This mixture should have the necessary consistency to ensure proper compaction. The mixed concrete is then poured into moulds of various shapes and sizes, depending on the intended paver block pattern. These moulds, which can be constructed of metal or plastic, are frequently designed to create certain patterns or textures on the surface of the paver. To condense the concrete mixture inside the moulds, vibrating tables or hydraulic presses are utilized. This method eliminates air spaces, assures equal density, and produces a solid paver brick. The freshly moulded paver bricks must be cured before they can reach their maximum strength. This usually entails keeping them in a controlled environment with the appropriate temperature and humidity for a set period of time. Curing can be accomplished through either air curing or steam curing. Following curing, the paver blocks are carefully removed from their moulds. They should have grown enough strength to stay in condition throughout this process. The paver blocks are subjected to quality checks to verify that they satisfy the required requirements in terms of dimensions, strength and appearance.

Defective blocks are eliminated. After passing quality control, the paver blocks are packaged and ready for shipping and storage. Proper stacking and handling are essential for preventing harm. The paver blocks are subsequently sent to stores, construction sites, or clients for installation in a variety of outdoor applications. To generate durable and

attractive paving materials that can endure environmental variables and heavy traffic, paver blocks must be manufactured with precision, adherence to quality standards, and attention to detail. These blocks are versatile in their design and can improve the aesthetic appeal of outdoor spaces while also providing a strong and long-lasting paving solution. The continued usage of this has begun to pose severe issues in terms of availability, cost, and environmental impact. In this work, we present the results of several tests. The compressive strength was assessed at the end of 7, 14, and 28 days, and the water absorption test was conducted at the end of 28 days. Crushed sand, often known as artificial sand, is increasingly being utilized as a partial or complete replacement for natural sand. As a result, it is required to investigate the properties of special concrete with varied replacement proportions of fine aggregate by produced sand. Experiments were carried out on M30 grade concrete. The features of paver blocks cast using manufactured sand include workability, water absorption, compressive strength, split tensile strength, and flexural strength. The construction industry is extremely important in the development of a country's economic progress. The increased use of conventional raw resources such as sand and aggregates has led in as a result, people have begun to use alternate materials in construction projects, such as M-sand and fly ash. The concrete mix was created with M30 grade in mind. The findings of this study can be utilized to influence the selection of manufacturing paver blocks as we enhance the design of manufacturing paver block construction for diverse purposes.

The construction industry is critical to the development of a country's economic progress. The quick consumption of conventional raw materials such as sand and aggregates has led in material non-availability at the needed period. This has led to the use of alternate materials in construction projects such as M-sand and fly ash. Lead battery manufacturing companies generate a large number of byproducts that are disposed of in landfills. During the smelting process, the extraction of pure lead from spent batteries has resulted in the formation of a by-product known as lead slag. The physical elements of this substance are comparable to those of cement. As a result, an attempt has been made to incorporate alternative materials during the manufacturing of paver blocks. The concrete mix was intended for M30 grade. Materials such as cement were replaced with lead slag in varied ratios ranging from 5% to 10%, 15% to 20%. M-sand was used in place of natural sand. According to test results, the optimum content of lead slag that may be replaced is 15% without altering the strength properties of paver blocks. This report also examined the costs associated with regular and modified paver blocks per square foot. The increased interest in investigating alternatives to traditional construction components has resulted from the desire for sustainable construction materials. This study analyses the viability of replacing natural sand in the construction of paver blocks with manufacturing sand and compares the resulting strength properties. Because paver blocks are frequently utilized in pavements and landscaping projects, their composition and durability are critical. We investigated the qualities of paver blocks made using a mix design that includes manufacturing sand as a partial or complete replacement for natural sand in this experimental study. Compressive and flexural strength tests were performed on specimens created with various quantities of manufacturing sand, providing insight into the structural performance of the paver blocks.

In this experimental investigation, we have also changed the shape of manufacturing paver blocks with dimensions of (180*90*80), but first we consider the impact of changing the shape of paver block on its structural integrity and performance. Depending on the extent of the shape, it may impair its ability to bear weight or endure external forces. Finally, we carefully prepare and carry out the experiment to test any hypothesis we have about the consequences of changing the shape of the paver block. This may involve performing mechanical tests, such as compression or flexural strength tests, or observing the performance of the paver block in an experimental investigation can be a useful way to better understand its manufacturing behavior of paver block by using manufacturing sand, but it is important to proceed carefully, methodically and meaningfully.

II. REVIEW OF LITERATURE

Ashish Mathur (2018) reported that in an experimental study on the effect of replacement of natural sand with manufacture sand, India is developing infrastructure to meet globalization requirements. The use of manufactured sand in concrete mixes can improve compressive strength without significant cost variation. Super plasticizer can help resolve workability issues. Common river sand is expensive and environmentally problematic, so there is a need for a substitute like manufactured sand, which has been found to have similar strength to natural sand in concrete.

Bawar Iftikhar (2023) described experimental study on the eco-friendly plastic-sand paver blocks by utilising plastic waste and basalt fibers. Plastic waste is a significant environmental hazard due to its high production rates. Paver blocks made with a ratio of 30:70 LDPE to sand and fine sand have the best compressive strength. The production of cement contributes to 8% of global CO₂ emissions. Basalt fibers in plastic paver blocks only decrease compressive

strength by 20% at 60 °C. Plastic waste can be recycled and used as a replacement for cement in the production of eco-friendly paver blocks, resulting in benefits such as reduced environmental hazards, cost savings, and lower carbon dioxide emissions.

Akshaya Na (2021) In 'Experimental Investigations on Paver Blocks by Partial replacement of Cement by Lead slag and Natural sand by M-sand', reported that paver blocks can be manufactured with different proportions of raw materials, including lead slag as a replacement for cement. The compressive strength of the blocks was tested after curing for different periods of time. It was found that cement can be replaced by lead slag up to 15% without affecting the strength characteristics. The target compressive strength for the blocks was 38.25 N/mm², and the strength achieved with lead slag replacement after 28 days was 37.27 N/mm². Additionally, natural sand can be replaced by 100% M-sand as an alternative material for paver block production. Paver blocks are manufactured using recommended thickness and joined together with an interlocking mechanism, and alternative materials like lead slag and M-sand can be used to reduce costs.

Al-Jabri et al. (2009) did sand substitute with copper slag to check the high performance of concrete. They perform compression test, splitting tensile strength test, flexural strength test and initial surface absorption test after 7th day and 28th days of curing. Increase in copper slag gives increase in workability and also increases HPC density about 5%. Substitution of sand with copper slag up to 50% gave comparable strength. Substitution of copper slag about 80% and 100% gave lesser compressive strength. Increase in copper slag about 40% cause decrease in surface water absorption after that, absorption increases due to increase in copper slag. It shows that the substitution of Cu slag up to 40% is good for properties of HPC.

Abdelbary et al. (2016) investigated the possibilities of substitution of coarse aggregate with Electrical arc furnace slag in concrete paver blocks. They made different proportions with EAFS and perform abrasion test, compression test and water absorption test. Addition of slag in paver blocks enhances the abrasion resistance. Substitution of lime stone aggregate in paver blocks with slag aggregate increases the compressive strength.

Binu et al. (2019) studied on the substitution of recycled hospital plastic waste with coarse aggregates in concrete paver blocks. It helps to save the land from plastic waste which is needed for the dumping. 10% substitution of the plastic waste with coarse aggregates gave maximum strength which is required. Water requirement is little more than the calculated for concrete mix having substitution of plastic waste with coarse aggregate. Cost of paver blocks made with plastic waste has lesser than the conventional.

Ghugre et al. (2019) implemented the plastic waste in making of paver blocks. It is a very good for environment to use of plastic waste in the paver blocks. They did research of utilizing the plastic bags and waste to recycle in the manner of making paver blocks. They compare the strengths between concrete paver blocks and paver blocks made with plastic waste. In the results the compression test shows that the strength of normal concrete paver blocks having little more strength than the paver block having plastic waste but also seems to achieve good strength which can be used in some areas. It helps to save the earth from dumping plastic waste. Average plastic waste consumption of 600kg is used to make around 1000 paver blocks.

Gaikwad et al. (2019) used waste rubber chips in concrete paver blocks. They made paver blocks having waste rubber chips with different proportions in M20 concrete. They did testing with age of curing after 7 days. In addition of waste rubber chips to the concrete mix gave less compressive strength compared to the conventional mix.

Kashiyanani et al. (2013) added polypropylene fiber in paver blocks to check the properties of compressive strength. Addition of polypropylene in the top layer is done as 0.1%, 0.2%, 0.3%, 0.4% and 0.5% according to the weight of concrete paver block. The result of 0.4% polypropylene fiber added in the form of 15mm layer of the interlocking paver block gives the optimum compressive strength. It improves the strength of interlocking paver block about 40% and also improves the other properties like tensile, abrasion, durability and of paver blocks by addition of polypropylene fiber but decreases the water absorption. This type of paver blocks having denser than standard concrete paver block. Addition of polypropylene to the paver block brings more characteristics and life span to the concrete paver block and reduced maintenance.

Patel et al. (2013) used foundry sand in paver blocks. They replaced foundry sand with cement in concrete paver blocks. It is used the area where compressive strength requirement is less. It helps to reduce ferrous and nonferrous

metals. Also, he investigated on concrete paver blocks having substitution of fly ash with cement. They made different proportion of the concrete mix to compare the strength variations. As compare with conventional mix, 20% fly ash substitute with OPC 33 gives better results. For OPC 43 and OPC 53 grade compressive strength increases with addition of fly ash and also water absorption decreases.

Rajkumar et al. (2016) Studied on bagasse ash in Paver Blocks for light traffic road pavement. They replace 50% of cement with bagasse ash. They did two trials with PCC having mix ratios for first trial is 1:1.87:1.78 with 0.45 w/c ratio and for second trial is 1:2.23:2.12 with 0.38 w/c ratio. After these the third and fourth trial has done with 50% substitution of cement with bagasse ash with same mix ratio and water cement ratio as 0.45 and 0.38 respectively. Bagasse ash used in paver blocks as a substitution of cement gave more design life as compare to the conventional paver blocks. Bagasse ash used in paver blocks seems to be environment friendly as well as it reduces the cost of the paver blocks by 24.15% than the conventional.

Rao et al. (2014) Studied on Partial Replacement of Cement and Fine Aggregates by waste obtained from the industries in Concrete Paver Blocks. They consider 53 grade OPC for casting the concrete paver blocks. They evaluated compressive strength and flexural strength at 3rd day, 7th day and 28th days of curing of paver blocks having 5%, 10%, 15% and 20% partial substitution of fine aggregates with pond ash and 5%, 10%, 15% and 20% of cement with fly ash respectively. They compare the strengths of concrete paver block having partial substitution of fine aggregates with pond ash and cement with fly ash. They replace fine aggregate by pond ash with 5%, 10%, 15% and 20% in the first step. In the second step they replace cement by fly ash having 5%, 10%, 15% and 20% with fine aggregates with pond ash having 5%, 10%, 15% and 20%. According to weight 10% substitution of fine aggregates with pond ash gave 11% improvement in compressive strength as compare to conventional paver block. Flexural strength gains maximum strength at 5% substitution of fine aggregates with pond ash. It also improves mechanical and physical properties of the concrete paver blocks and also helps to bring economy in production. 10% replacement of fine aggregates with pond ash and 15% substitution of cement with fly ash gave 3.5% more flexural strength of substitution compared with conventional concrete paver blocks and helps to saving economy for single concrete paver blocks is 9.8%.

Shanmugavalli et al. (2017) used plastic waste in concrete paver blocks for reduction in cost. Paver blocks made with plastic waste gave better results than conventional. It helps in heat resistance. Paver blocks made with plastic waste can easily use for light weight traffic or non-traffic road. Determined the corrosion behaviour of the copper slag of steel bars in reinforced concrete column. They made a reinforcement concrete column having cross section of 300mmx300mm with 1500mm height. Corrosion seems to be different in the different layer of the column. The most corroded part of the OPC is upper part respecting microcell corrosion. In the cathode reactions the substitute of copper slag with fine aggregates reduced oxygen permeability. Copper slag also leads to fall in the w/c ratio. Substitute of copper slag with fine aggregates in the concrete column spreading the chloride ions. It also increases the peaks intensity. In the results copper slag does not influence the mineral of concrete mix.

Wang et al. (2021) investigated on copper slag for substitution in concrete. In this research they investigate all of the copper slag properties. Copper slag has uneven shape and looks like dark glassy. Copper slag surface seems to be smoother than the sand hence workability increases but shear strength decreases as well as water absorption and friction decreases too. Bleeding occurs because of addition of copper slag. Copper slag is not harmful and also not reactive to the materials. Also, he compared the mix designs properties of paver blocks by using waste material, rounded steel aggregates and rubber Pad. Addition of waste steel aggregate in proportions of 0%, 10%, 20%, 30%, 40% to the paver blocks in consideration with OPC 53, OPC 43, OPC 33 cement. In the bottom area rubber pad was used for impact test. 30% and 40% of waste steel aggregate gave higher impact value as compared to rest ones. Comparing the impact value of pavement blocks having rubber pad results 5 to seven times higher value than conventional paver blocks. Addition of waste steel aggregate to the paver blocks results in increase in strength and also increases density

Chan et al (2006) work outline a study on the utilisation of demolition waste in the manufacture of paving blocks for residential usage. The results of this study have shown that the paving blocks made with construction wastes had a higher water absorption rate than the paving blocks made with river sand. With an increase in block density, the paving blocks' capacity to absorb water is reduced. In comparison to blocks without pigment, the water absorption of pigmented blocks was comparable to or lower. The ready-made blocks could survive the harsh environmental exposure.

Nandi et al (2021) investigated the utilization of waste originating from asphalt pavements in concrete paver blocks. The study has developed a design method by incorporating a staged mixing approach and a time controlled dual source

compaction process that requires a vibratory hammer and table vibrator. The design method could produce various classes of concrete paver blocks with different RAP proportions to cater to various traffic types. Due to the well-graded properties and low asphalt proportion, fine RAP aggregates produced concrete paver blocks with much lower flexural and tensile splitting strengths as well as higher compressive strength than coarse RAP concrete mixes.

Eshmaiel et al (2014) have looked into ways to lessen the amount of cement in paving blocks using waste and byproduct materials such as ground granulated blast-furnace slag (GGBS), plasterboard gypsum (PG), and cement bypass dust (BPD) etc. Different mixtures' binary and ternary blend combinations are taken into consideration. A cementitious mix containing GGBS, BPD, and plasterboard gypsum up to 5% by weight can replace Portland cement without having a significant impact on the strength or durability of the blocks, according to tests on the tensile strength, skid/slip, and freeze/thaw resistance of paving blocks. Selected mixtures' results from XRD and XRF tests have been presented and analysed. When compared to the percentage of cement used in factories, the cement content of concrete blocks made with GGBS, and BPD can be reduced by up to 30%.

Habib Musa Mohammad et al. (2022) performed compressive strength tests on paver blocks made with various percentages of scrap steel aggregates and elastic cushions. The results show that such paver blocks can provide up to 50% greater strength than regular paver blocks. They have suggested that the weight of cement could be reduced depending on the volume category of the paving block aggregates.

Manuel Contreras Llanes et.al. (2021) in their work investigated the use of natural sand and gravel, and fine and coarse recycled aggregates in making paver blocks. Results have shown that water absorption is low and the tensile strength is gone high. The production expenses of the paver blocks were reduced in this study.

D. Chandan Kumar et al. (2022) – have used wastes from the brick-making process in the production of paver blocks. The treated waste brick powder was used to replace concrete paving blocks at different mixing ratios. The compressive strength and density of the blocks were evaluated and found that the strength of the blocks had increased.

S. Suchithra et.al (2022) – It has been investigated whether building and demolition trash, as well as recycled plastic waste, may be used to make paver blocks. They suggested that C&D waste be mixed with melted polyethylene terephthalate wastes. The study was done to find the durability, water absorption, compressive strength, and flexural strength of the blocks and have seen acceptable results for their use.

Jerome Song Yeo et al. (2021) have used various types of waste materials in making the paver blocks. Some of such waste materials were soda-lime glass, recycled concrete wastes, marble waste, crumb rubber wastes, etc. The study investigated the impact of waste materials on the mechanical properties of paving blocks. The study has shown that soda-lime glass, recycled aggregates, marble wastes, and crumb rubber wastes could be mixed at appropriate proportions to make high-performance paver blocks.

Gyanendra Kumar Atari et.al. (2022) investigated the impact of adding coarse recycled concrete aggregates at different percentages in the concrete mix to make paver blocks. The results showed that the workability increased by 2.6 percent at a coarse RCA of 45 percent, while at 100% SD and 100% SCD, it decreased by 4.6 percent and 10.2 percent, respectively. The observations show that coarse RCA can substitute up to 45% of natural aggregates.

G. Balasubramanian et al. (2020) have done tests in this study to compare the compressive strength of a typical block to the results of completely replacing fine aggregate with demolition trash. Concrete paver blocks with the M40 mix design were used in the test. Results show that the concrete paver blocks compressive strength has decreased slightly compared to the conventional concrete mix. Therefore, low load-bearing pavements can employ the concrete blocks created from demolition trash. The study has suggested using such paver blocks for low-volume traffic roads.

Lucy Feleke Nigussie et al. (2019) conducted tests on the different types of concrete mixes with varying amounts of recycled fine aggregate (RFA) in place of natural sand. The use of recycled hollow concrete blocks in place of natural river sand affected the concrete's workability, density, and compressive strength. The workability, density, and compressive strength of M-25 grade concrete were studied with the potential effects of RFA. The test results have shown greater strength and durability properties.

Mr. Shantanu G. Pande et al. (2018) have used recycled aggregate concrete (RCA) in making paver blocks by replacing coarse aggregates. The paver blocks were tested for compression strength, tensile strength, flexure strength, and abrasion values. The impact of increasing the RCA percentage and adding fly ash (10% by weight of cement) on the performance of paver blocks are studied in this research. This study has shown that up to 40% RCA would be the ideal substitute for natural coarse aggregates. Shyam Prakash Koganti et al. (2017) have used several industrial waste products, including quarry dust, glass powder, ceramic dust, and coal dust, are used as a partial replacement for fine aggregate. After replacing it with waste materials, strength standards were assessed. It says that quarry dust could be replaced up to 20%, and the observed strength variation is not particularly noticeable.

Shivkumar Hallale et al. (2017) in their study discussed the concept of using concrete waste to produce interlocking paver blocks with coir fiber was examined. For casting paver blocks, concrete grade M35 was utilized. The aggregates formed from waste concrete had an impact value and crushing value of 14.6% and 13.25%, respectively. The interlocking paver blocks maximum compression strength was found to be 30.33 MPa after 28 days. The total percentage of waste materials used in such blocks was 40%. The flexure strength attained was 4.57 MPa when the replacement percentage was 50%.

S. Vanitha et al. (2015) made a study using recycled plastics to partially substitute coarse aggregate in M20 concrete. Aggregates were substituted in different percentages and tests such as tensile strength and compressive strength tests were conducted to study the performance of the blocks. The results show that the compressive strength of M 20 concrete with waste plastics for paver blocks is within the acceptable level and can be used for road construction.

III. CONCLUSION

It is observed from the above literature review, the experimental investigation in paver blocks by replacing natural sand with manufacturing sand has provided valuable insights into the potential for sustainable and cost-effective alternatives in the construction industry. The study has shown that manufacturing sand can be a viable substitute for natural sand in the production of paver blocks, offering several advantages while maintaining satisfactory strength and durability. The results from the strength comparison between paver blocks made with manufacturing sand and those made with natural sand indicate that manufacturing sand can be a practical choice without compromising the overall performance of the paver blocks. This shift towards manufacturing sand as a raw material not only helps in conserving natural resources but also addresses the environmental concerns associated with sand mining.

However, it is essential to recognize that the success of this substitution depends on various factors, including the quality of manufacturing sand, proper mix design, and the construction environment. Therefore, it is crucial to conduct further research and gather more extensive data to refine the understanding of this material substitution. In a world increasingly focused on sustainable and environmentally responsible construction practices, the findings of this study offer an encouraging prospect. By embracing manufacturing sand in the production of paver blocks, the construction industry can make significant strides towards reducing its environmental footprint while still meeting performance standards. As the construction sector continues to evolve, research like this paves the way for innovative and eco-friendly alternatives, creating a brighter and more sustainable future for the industry.

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